International Journal of
Scientific Engineering and Technology Research

ISSN 2319-8885
Vol.07,Issue.04,
April-2018,
Pages:0866-0870

www.ijsetr.com

Study of Cost Effectiveness in Design of Structures with High Performance Concrete

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Abstract: The attention on High Performance concrete (HPC) has tremendously expanded because of use of substantial amount of cement, in this way prompting the improvement of framework Viz., Buildings, Industrial Structures, Hydraulic Structures, Bridges and Highways and so forth. This paper incorporates the itemized think about on the current improvements in High Performance Concrete, focusing on additional on the quake inclined territories. It features the points of interest and significance of High Performance concrete over ordinary cement and furthermore incorporates impact of Mineral and Chemical Admixtures used to enhance execution of cement. The conduct of SIFCON is likewise talked about quickly. The option for the HPC is likewise prescribed.

Keywords: Tremendously, Substantial, Hydraulic, Performance, Admixtures.

I. INTRODUCTION

Concrete is the most generally utilized development material in India with yearly utilization surpassing 100 million cubic meters. Additionally, the current seismic tremors in various parts of the world have indeed uncovered the significance of outline of structures with high malleability. The quality and flexibility of structures primarily relies upon legitimate itemizing of support in shaft segment joints. Under seismic excitations, the shaft section joint district is subjected to high flat and vertical powers whose extents are substantially higher than those inside the adjoining pillars and segments. Traditional Ordinary Portland Cement Concrete which is outlined based on compressive quality does not meet numerous useful prerequisites as it is discovered deficiency in forceful conditions, time of development, vitality assimilation limit, repair and retrofitting employments and so forth and loses its malleable protection after the arrangement of various splits. In this way, there is a need to plan High Performance Concrete which is far better than Conventional Concrete, as the Ingredients of High Performance Concrete contribute most proficiently to the different prerequisites. The quality "Superior" suggests an enhanced mix of basic properties, for example, quality, strength, vitality ingestion limit, solidness, sturdiness, numerous splitting and consumption protection, considering the last cost of the material or more all, of the create made.

As a rule, superior is intended to recognize auxiliary materials from the traditional once, and also to streamline a blend of properties in term of definite application in structural designing. HPC cements are typically composed utilizing materials other than bond alone to accomplish these necessities, for example, Fly Ash (from the coal consuming procedure), Ground Blast Furnace Slag (from the steel making procedure), or Silica seethe (from the diminishment of top notch quartz in an electric bend heater). Diverse measures of these materials are joined with Portland concrete in differing rates relying upon the particular HPC necessities. In spite of the fact that there are numerous definitions for High Performance Concrete (HPC), the most generally acknowledged one is that given by the American Concrete Institute (ACI), which states; "Elite Concrete will be solid that meets exceptional execution and consistency necessities that can't generally be accomplished routinely by utilizing just regular materials and ordinary blending, putting and curing rehearses." It isn't conceivable to give a remarkable meaning of HPC without deciding the execution prerequisites of the proposed utilization of the solid. The prerequisites may include upgrade of qualities, for example, situation and compaction without isolation, long haul mechanical properties, and early age quality or administration life in serious conditions. Cements having a significant number of these attributes regularly accomplish High Strength, yet High Strength cement may not really be of High Performance. An arrangement of High Performance Concrete identified with quality is demonstrated as follows.

TABLE I:

Compressive Strength (MPa)	50	75	100	125	150
High Performance Class	I	II	III	IV	V

II. APPLICATION OF ADMIXTURES

Admixtures assumes enter part in the generation of High Performance Concrete. Both Chemical and Mineral Admixtures shape a piece of the High Performance Concrete blend. The significant contrast between Conventional Cement Concrete and High Performance

Concrete is basically the utilization of Mineral Admixtures in the last mentioned.

TABLE II: Different Mineral Admixtures used in HPC

Mineral Admixtures	Classification	Particle characteristics
Ground granulated blast furnace slag	Cementitious and pozzolanic	Unprocessed materials are grain like sand, ground to size <45 µm particles and have a rough texture
Fly ash	Cementitious and pozzolanic	Powder consists of particles size <45 µm, 10% to 15% are more than 45 µm, solid spheres and generally smooth
Silica fume	Highly active pozzolana	Fine powder consisting of solid spheres of 0.1 µm average diameter
Rice husk ash	Highly active pozzolana	Particles are <45 µm in size and have cellular and porous structure

Substance structure decides the part of Mineral Admixtures in upgrading properties of cement. Diverse materials with Pozzolanic properties, for example, Fly Ash (FA), Ground Granulated Blast Furnace Slag (GGBS), Silica seethe (SF), High Reactivity Metakaolin (HRM), Rice Husk Ash (RHA), Copper Slag, Fine Ground Ceramics have been generally utilized as supplementary cementitious materials in the creation of High Performance Concrete. Fly Ash (FA) and Silica smolder (SF) go about as Pozzolanic materials and additionally fine fillers; along these lines the microstructure of the solidified concrete lattice ends up denser and more grounded. The utilization of Silica seethe fills the space between concrete particles and amongst total and bond particles. It doesn't give any quality to it, however goes about as a quick impetus to pick up the early age quality.

TABLE III: Different Chemical Admixtures used in HPC

Chemical Admixtures	Function
Super Plasticizer	To reduce the water requirement by 15% to 20% without affecting the workability leading to a high strength and dense concrete
Accelerator	To reduce the setting time of concrete thus helping early removal of forms and therefore used in cold weather concreting
Retarder	To increase the setting time by slowing down the hydration of cement and therefore are preferred in places of high temperature concreting
Water reducing admixture	To achieve certain workability (slump) at low water cement ratio for a specified strength thus saving on the cement
Air entraining admixture	To entrain small air bubbles in concrete which act as rollers thus improving the workability and therefore very effective in freeze-thaw cycles as they provide a cushioning effect on the expanding water in the concreting in cold climate

Such applications not just enhance the quality and solidness attributes of High Performance Concrete however will likewise arrange a greater amount of the mechanical results which are major ecological dangers. Diverse Chemical admixtures (Super plasticizers) are widely utilized as a part of advancement of High Performance Concrete, as they increment the effectiveness of bond glue by enhancing workability of the blend and in this manner bringing about extensive decline of water prerequisite. Plasticizers and Super Plasticizers help to scatter the bond particles in the blend and advance versatility of the solid blend. Retarders help in decrease of beginning rate of hydration of bond with the goal that crisp cement holds its workability for a more drawn out time. Air entraining specialists falsely present air bubbles that expansion workability of the blend and upgrade the protection from weakening because of solidifying and defrosting activities.

III. LITERATURE REVIEW

Beam - column joints have been recognized as critical elements in the seismic design of reinforced concrete frames (ACI 1999, AIJ 1990, Euro Code 1994, SNZ 1995). Numerous studies were conducted in the past to study the behaviour of beam-column joints with normal concrete (Shamim and Kumar 1999, Gefken and Ramey 1989, Filiatrault et al 1994). ACI- ASCE committee 352 (2002) makes recommendation on the design aspects of different types of beam-column joints, calculation of shear strength, and on reinforcement details to be provided (ACI 2002). These recommendations are however not intended for fiber reinforced concrete. Bakir (2003) conducted extensive research on parameters that influence the behaviour of cyclically loaded joints and has derived equations for calculating shear strength of the joints. A study conducted on fiber reinforced normal strength concrete by Filiatrault et al (1994) indicated that this material can be an alternative to the confining reinforcement in the joint region. The study conducted by Gefkon & Ramey (1989) illustrated that the joint hoop spacing specified by ACI-ASCE committee can be increased by a factor of 1.7 by the addition of fibers in the concrete mix. Jiuru et al (1992) studied effect of fibers on the beam-column joints and developed equation for predicting shear strength of joints for normal strength concrete.

Bayasi and Gevman (2002) also experimentally proved the confinement effects of fibers in the joints reason and reduction in thelateral reinforcement by the use of fiber concrete. Besides these, there are several investigations on the effect of addition of fibers on the strength and durability of flexural members. Oh (1992) also indicated that the ductility and ultimate resistance of flexural members are increased remarkably due to the addition of steel fibers. ACI committee 544(1998) also reported considerable improvement in strength, ductility and energy absorption capacity with an addition of steel fibres. All these studies are, however, confined to normal strength concrete and the research in the area of High Performance Lightweight Fibrous Concrete joints is limited. Yung Chih Wang (2007) studied reinforced concrete beam column junctions strengthened with Ultra high steel Fiber reinforced Concrete (UFC). It was concluded that UFC displayed excellent performance in terms of mechanical and durability behaviour. The test results showed that UFC replaced joint frame behaves very well in seismic resistance. The performance was found to be much better than the frame strengthened with RC jacketing as normally seen in the traditional retrofit schemes.

Kiyoung-Kyuchoi (2007) conducted analytical studies to investigate punching shear strength of interior slab-column connections made of steel fiber reinforced concrete. A new strength model for the punching shear strength of SFRC slab-column connections was developed. Singh & Kaushik (2001) studied behaviour of fiber reinforced concrete corners under opening bending moments. It was indicated that there is a noticeable gain in efficiency with increase in fiber volume fraction up to a certain limit beyond which there is a drop in mix workability and joint efficiencies. Kilar et al (2003) explored the possibilities to use high performance concrete for the design of seismic resistant cost effective and durable buildings. Building frames made up High Strength Light Weight Aggregate Fiber Reinforced Concrete (HPLWAFRC) were tested and analyzed under dynamic loads and the response of building in terms of force displacement relationship and rotation ductility factors were investigated. Kumar et al (2010) studied the use of Slurry Infiltrated Fibrous CONcrete (SIFCON) as a substantial material in RC beams. It was reported that SIFCON can be used in places where structures need to be designed to resist impact loads. It was also concluded that with proper design the cross-section can be optimized by replacing certain portion by SIFCON.

The literature review of previous works conducted by various researchers on high performance fibrous concrete structural systems illustrates that most of the researchers have used Steel Fiber Reinforced Concrete (SFRC) at the beam – column junctions. The fiber contents were restricted to 2% by volume. It was observed that the enhancement in terms of strength, ductility, energy absorption capacity, toughness and other structural properties was not significant, primarily because of low fiber volume contents. The effect of fiber types, fiber volume content and aspect ratio was also not studied. Further, most of the research work was restricted to the study of behaviour of structural members independently using normal weight concrete only. Very few researchers have studied behaviour of beam-columns and beam-column-slab junctions collectively. Since beam-column & beam-column-slab junctions are the vulnerable locations which are subjected to high horizontal & vertical forces whose magnitudes are much higher than those within the adjacent beams & columns, the use of SFRC was found to be inadequate.

IV. BEHAVIOUR OF SIFCON

Slurry penetrated sinewy cement (SIFCON) presented by David Lankard [20], is a composite material using short steel filaments in a bond based lattice. SIFCON composites contrasts from traditional FRC in which the steel strands are straightforwardly added to solid blend in the proportion of 1-3% by volume, while, SIFCON utilizes framework comprising of fine particles prompting a bed of very much compacted steel filaments in the scope of 5-20% by volume [21]. The filaments in SIFCON are subjected to frictional and mechanical interlock notwithstanding the bond with the lattice. The grid assumes the part not just of exchanging of powers between strands by shear yet additionally goes about as bearing to keep the filaments interlocked. All in all, when filaments are added to concrete, malleable strain in the neighbor-hood of strands enhances fundamentally. On account of elite fiber-fortified cement, since the solid is thick even at the small scale structure level, pliable strain would be significantly higher than that of customary SFRC. This thus, will enhance splitting conduct, flexibility and vitality retention limit of the composites. Keeping in mind the end goal to tap the capability of Slurry Infiltrated Fibrous High Performance Concrete (SIFHPC), the current group of learning has been extended to explore the execution qualities of SIFHPC shaft section and bar segment chunk joints under positive cyclic stacking.

V. OBJECTIVES

In a quickly changing worldwide world, the antagonistic outcomes of catastrophic event on the general public, economy and condition can't be over-underlined. Late encounters of Jammu and Kashmir and Bhuj seismic tremors, and furthermore the North India Flood that struck Uttrakhand, indeed uncovered low quality development techniques, absence of readiness in safeguard and restoration, and so forth. As of late, the advancement in the solid innovation is immediate consequence of the expanded interest for the development business to fortify and redesign the current solid structure. This might be because of different reasons, for example, ecological corruption, plan deficiencies, poor development rehearses, increment in stack, correction of codal arrangements, and surprising seismic stacking conditions. The primary goal of present research is to contemplate High Performance Concrete.

VI. METHODOLOGY

The cost of common framework constitutes the significant bit of the national riches. Its quick decay has made a dire requirement for the advancement of novel, dependable and financially savvy techniques for new development, repair and retrofit. Promising method for settling this issue is to specifically create propelled composites, for example, HPRC. Novel development methodologies can be produced with such materials that will prompt considerably higher quality, seismic protection, strength and pliability while development likewise being quicker and more financially savvy than regular strategies. Bar segment joints utilizing HPRC will be built and tried under flexural cyclic stacking. Elite Concrete (HPC) blend extents for M60 and above will be planned according to ACI 211 rules (ACI1998) and changed by Aitcin (1998). Some portion of the concrete will be supplanted by smaller scale fillers, for example, silica vapor and fly-powder. Same blend extent will be kept up for all the blends. The normal information acquired from test examinations will be used to research execution qualities of shaft segment joints, to satisfy quality, toughness and serviceability prerequisite. Comparative examinations will likewise be led on pillar segment - piece joints to explore their auxiliary execution in the light of previously mentioned parameters. Explanatory examinations will likewise be directed to ponder conduct of pillar segment and bar section - piece joints by using HPRC. Basic variable point truss model might be utilized to outline the joint shear exchange instrument. In like manner, shear quality of joints will likewise be assessed by utilizing different explanatory models accessible in the writing (for typical quality cement) after reasonable alterations for HPRC. The aftereffects of systematic investigation will be contrasted and exploratory outcomes and a proper outline method and rules will be proposed relating to the auxiliary use of HPRC in different basic frameworks.

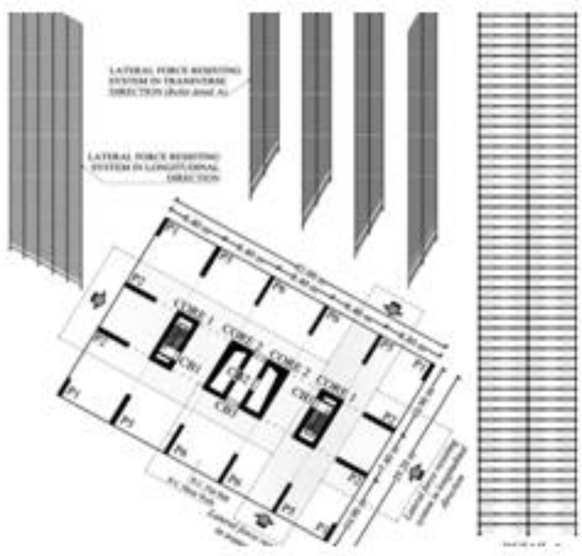

Fig.1. Modeling approach of reference structures for inelastic analysis: (a) ZEUS-NL fiber-based models in the longitudinal and transverse directions, and (b) building layout.

VII. CONCLUSION

Numerous endeavors have been connected towards growing elite cement for building structures with upgraded execution and wellbeing. Numerous solid items like Autoclaved Aerated Lightweight Concrete (AALC), Fiber Reinforced Concrete (FRC), and Lightweight Concrete, have been created and tentatively confirmed. AALC is outstanding and generally acknowledged, however its little size and powerless quality point of confinement its utilization in auxiliary components [22]. Lightweight total cements offer quality, dead load diminishment, and warm conductivity, yet their restricted capacity to retain quake vitality raises concerns. Interestingly, FRC has more prominent vitality retaining capacity, which is called "pliability or inelastic distortion limit," than typical cement, yet its weight postures issues. Be that as it may, HPLWAFRC has better warm properties, fire rating and diminished autogenous shrinkage. It additionally has phenomenal solidifying and defrosting solidness, less small scale splitting because of better flexible similarity and has more imperviousness to fire and better stun and sound retention. Notwithstanding its enhanced auxiliary qualities, HPLWAFRC has less splitting and enhanced slip protection and is promptly set by the solid pumping strategy. The utilization of basic superior light weight concrete diminishes the dead load by around 25 to 35 rate when contrasted with typical weight concrete in this way offering considerable cost sparing by giving less dead load Improved seismic reaction, longer traverse, more slender segments, less fortifying steel and lower establishment cost, lessened trucking and position cost, additionally make this material more flexible for its applications.

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